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The Increasing Activity of a Vascular Ultrasound Service

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Objectives: *To examine the change in activity of a vascular ultrasound service over 7 years.*
Design: *Retrospective review.*
Setting: *Vascular studies unit, University hospital.*
Method: *Audit of the number of vascular ultrasound tests carried out over the last 7 years using a prospective computerised database.*
Results: *Data shows that the overall workload has tripled over the 7-year period. In addition the complexity of investigations has increased during this time. The number of carotid scans has increased four-fold while the number of graft surveillance scans and vein scans has increased seven-fold. Assessment of lower limb arteries has developed from simple pressure measurements to detailed ultrasound scans and, as a consequence, the number of diagnositc angiograms has fallen by 75%. The factors that have influenced these changes are discussed.*
Conclusion: *There has been an important increase in the role of colour Doppler ultrasound as it becomes the "first line" vascular diagnostic test. However this trend can only continue if vascular ultrasound services are appropriately resourced. It is therefore essential to maintain an efficient audit system.*

Key Words: Workload; Ultrasonography, Doppler, Colour; Peripheral vascular diseases; Angiography.

Introduction

The role of Doppler ultrasound in the diagnosis of vascular disease is well established but over recent years it has changed from simple ankle pressure measurements to a detailed examination of the arterial and venous circulations. This change has occurred because of rapid developments in technology from simple continuous wave Doppler systems to colour flow ultrasound scanners. Doppler ultrasound is an accepted non-invasive, relatively inexpensive technique for the investigation of vascular disease and evidence suggests that it compares well with angiography.[1–3]

Vascular ultrasound services in the U.K. are currently provided either by dedicated vascular studies units (usually run in collaboration between departments of surgery and medical physics) or as part of the main radiology service. Moreover the changing role of vascular ultrasound is not only affected by technological developments but also by the changing pattern of vascular referrals from vascular surgeons and other specialities.

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At Leicester Royal Infirmary the vascular ultrasound service is provided by a vascular studies unit (VSU) which is jointly operated by the Departments of Surgery and Medical Physics. Over the last 7 years a computerised record has been kept of all investigations carried out within the unit. The aim of this study was to evaluate the changing patterns of the VSU workload and the resources required to maintain this.

Materials and Methods

Composition of the vascular studies unit

The VSU at Leicester Royal Infirmary has been established for over 12 years and initially consisted of one technologist using CW Doppler and one black and white duplex ultrasound scanner. However, continued expansion of the vascular studies service has led to the addition of more staff and equipment. Table 1 shows the changing resources over the last 7 years along with the number of vascular consultants. The unit now comprises of vascular technologists (both technicians and clinical scientists), an audit co-ordinator, a research nurse and a dedicated secretary.

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Table 1. Whole time equivalent staff working in the vascular studies unit at Leicester Royal Infirmary along with the number of consultant vascular surgeons.

Year	1990	1991	1992	1993	1994	1995	1996
B&W scanner	1	1	1	1	0	0	0
Colour scanner	0	1	1	1	2	3	3
Technologists	1.5	2	3	3	3	3	3.5
Secretary	0.3	0.3	0.3	1	1	1	1
Audit co-ordinater	0.5	0.5	0.5	0.5	0.5	0.5	0.5
Research nurses	0.5	0.5	0.5	0.5	1	1	1
Vascular consultants	2	2	2	2	2	3	3

New vascular technologists employed by the unit since 1990 have required training, and this inevitably causes delay between the new member of staff arriving and finally becoming a productive member of the team.

Vascular studies unit databases

In 1989 a computerised audit of the vascular surgery workload including operations and complications was established using DBase 3b. Manual records of vascular ultrasound tests have always been maintained, but in 1990 there was a requirement for all VSU test details to be recorded on computer and DataEase was the system chosen by medical physics. This software proved to be much easier to use (both for data entry and data retrieval) and the operation audit data was therefore transferred from Dbase to DataEase and redesigned in late 1990. The method for data collection was updated in September 1992 with the computer programmed to now function as a diary. This system is still in use today.

Results

Figure 1 shows the annual number of tests carried out in the VSU over the last 7 years and indicates a threefold increase in workload. The only category of test to fall in numbers was the CW Doppler test, whilst all the other categories have increased significantly with time. The reduction in the overall number of tests recorded during 1992 was due to a 3-month period of incomplete data collection coinciding with conversion from one method of data collection to another.

Carotid scans

Figure 1 shows that, over the 7-year period of this study, the number of carotid scans has increased threefold from 452 in 1990 to 1858 in 1996. This coincides with a seven-fold increase in the number of carotid reconstructions performed in this unit.

Lower limb arterial investigations

Figure 2 shows the number of ankle pressure studies, walk tests and arterial leg scans performed during the study period. A bilateral leg arterial scan was counted as two separate studies, as each leg takes a minimum of 30 min to scan. Overall, there has been a decline in the number of walk tests since 1993, with a steady increase in the number of leg arterial scans. The number of ankle pressure measurements has gradually declined but over 500 measurements are still made each year. Figure 3 shows how the rise in the number of arterial leg scans has coincided with a 75% fall in the number of diagnostic angiograms.

Graft surveillance scans

Figure 4 shows that the number of graft surveillance scans has steadily increased since 1990 and then plateaus after 1994. During the same time period the number of infrainguinal reconstructions has remained unchanged.

Vein scans

Figure 5 illustrates the rapid increase in the number of vein scans performed annually. Currently the VSU performs in excess of 1000 vein scans per year. Bilateral and unilateral vein scans are both classed as a single test, taking approximately half an hour. The principle indications for vein scanning includes assessment of recurrent varicose veins and assessment of venous ulcer patients.

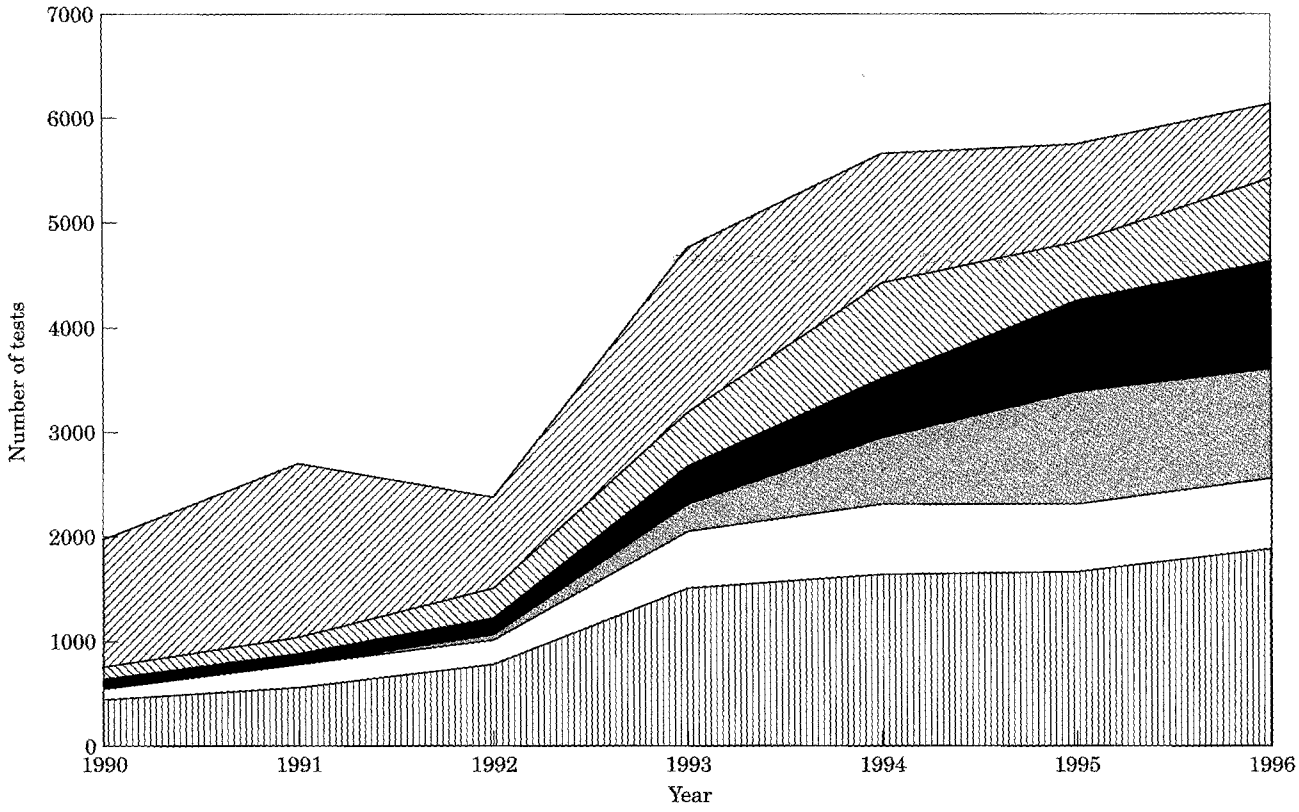

Fig. 1. The number of tests performed per year over the last 7 years broken down into the main diagnostic tests. (▨) CW Doppler; (▩) others; (■) vein scan; (▦) leg scan; (□) graft scan; (▥) carotid scans.

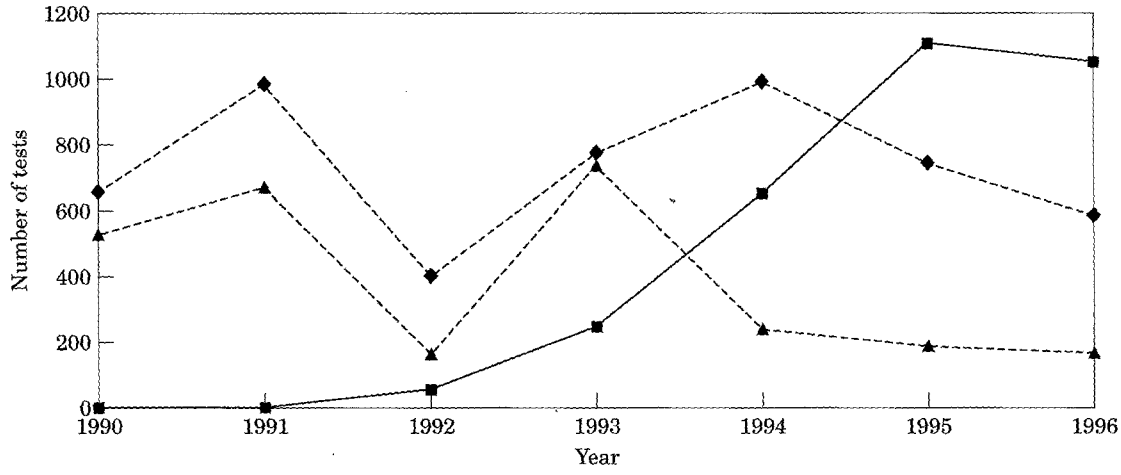

Fig. 2. The number of ankle pressures, walk tests and leg scans performed over the last seven years. (◆) Ankle pressures; (▲) walk test; (■) leg scan.

Discussion

Although the activity of the unit is partly governed by the number of available staff and ultrasound scanners, the waiting list for tests has never exceeded 2 months. Figure 1 shows the rapid growth in ultrasound investigations. The complexity of investigations provided has also increased as duplex ultrasound has steadily replaced conventional angiography and venography. The only category of test to fall was the CW Doppler test, which takes on average 15 min to perform, whilst duplex scans take 30 min or more to complete. This means that if time taken, complexity of the technique and equipment required are considered, the increase in workload is probably even greater than that indicated.

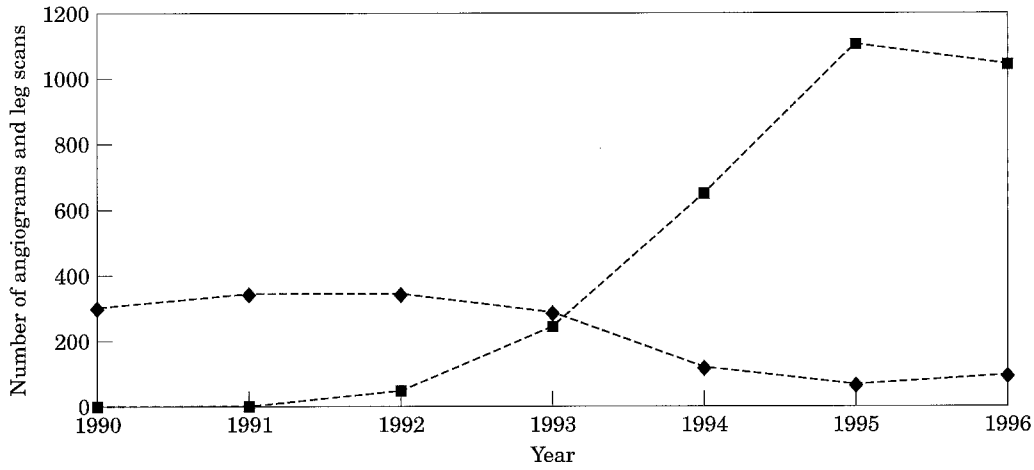

Fig. 3. The number of angiograms and leg scans performed over the last 7 years. (■) Leg scan; (◆) angiograms.

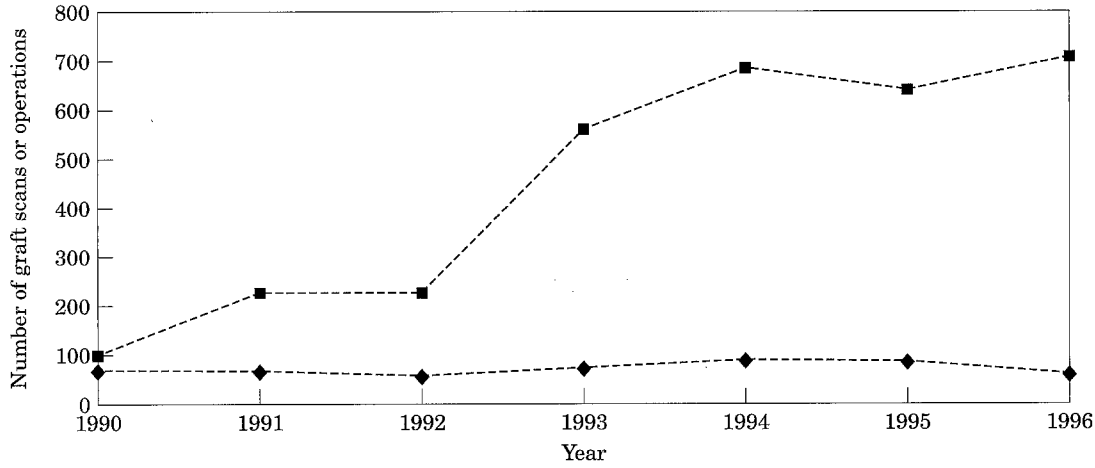

Fig. 4. The number of graft scans and graft operations performed over the last 7 years. (■) Graft scan; (◆) graft operations.

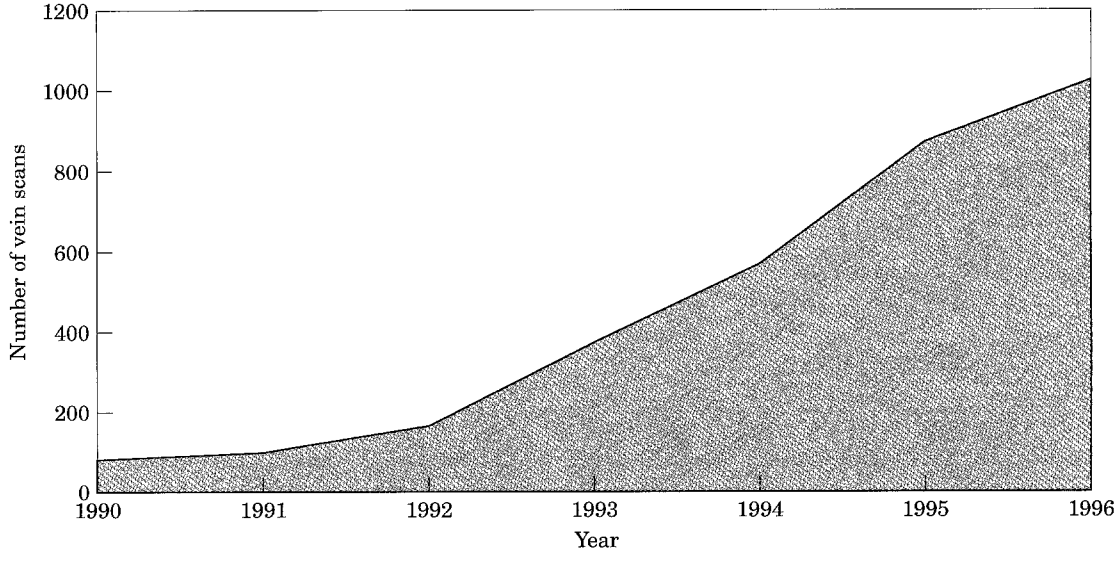

Fig. 5. The number of vein scans performed per year over the last 7 years.

Carotid scans

The steady increase in the number of carotid scans performed over the last 7 years may be due to the change in patient management that has occurred during this time, as well as the increased awareness of ultrasound as an accurate method of diagnosing carotid artery disease. In 1991 the results of the American and European Symptomatic Stenosis Trials[4,5] were published. As carotid duplex is a relatively inexpensive and non-invasive technique, it is appropriate that patients suffering from a transient ischaemic attack or stroke should be referred for a scan with a view to selecting patients for surgery. Ultrasound provides an accurate and reproducible means of evaluating carotid arteries.[1] Not only is ultrasound a preferable test for the patient, being non-invasive, but there are potential cost benefits as ultrasound equipment is relatively inexpensive compared to an angiography suite and only one sonographer is required to perform each investigation. Moreover, angiography carries a 2–4% risk of stroke. In this centre, 96% of patients undergo carotid endarterectomy without preoperative angiography.[2]

During the last 7 years the proportion of patients undergoing carotid scans who then proceeded to carotid surgery has steadily increased from 5%–8%. This may in part be due to the increase in number of patients referred from other centres for consideration for endarterectomy having been screened for severe stenoses elsewhere.

In addition, all patients undergoing carotid endarterectomy have a repeat carotid scan within 24h prior to surgery to ensure that there has been no change from the earlier scan. Moreover, the seven-fold increase in the number of carotid endarterectomies performed in this unit could have further workload implications because all patients undergo transcranial Doppler (TCD) monitoring during surgery. However, data regarding TCD monitoring has not been included in this paper as it is currently performed by research staff.

A significant proportion of our carotid scans are carried out as part of a "single visit clinic service". Patients attending the clinic are seen by the vascular surgeon and if necessary referred for a scan which is performed straight away. The patient then sees the consultant with the scan results, thereby allowing a decision on treatment to be made at the first visit. This saves the patient two return visits to the hospital but does add an unpredictable element to the workload of the VSU. The number of carotid scans is not increasing at the same rate as it did before 1993. This may be due to other local hospitals, who previously used our service, now performing their own carotid scans.

Lower limb assessment

Walk tests and ankle pressures have been carried out in the VSU since it was established in 1984. Walk tests are no longer routinely carried out during graft surveillance, although ankle pressures are still recorded where appropriate. The number of walk tests increased during 1993 as the VSU was involved in a study that used this test as a measure of success. After this, the number of walk tests fell dramatically as the number of arterial leg scans increased. There is still, however, a role for walk tests in the diagnosis of peripheral vascular disease in selected patients (e.g. those with claudication type symptoms and palpable pulses). The walk test is less time-consuming and requires less expensive equipment than a leg scan and gives a good indication of the severity of the disease and the degree of ensuing disability. Not all patients having a leg scan will have ankle pressures but they will have been assessed by a vascular surgeon before being referred for a scan. Patients who attend the vascular clinic and are found to have lower limb ischaemia will have a scan in clinic as part of the "single visit clinic service".

In 1992–1993 a prospective study was carried out to compare lower limb arterial ultrasound scans with angiography. The results from this study showed there was substantial agreement[3] between colour duplex and angiography of the lower limb, suggesting that vascular ultrasound could be used to replace conventional diagnostic angiography. As a consequence the hospital provided funding for an additional permanent vascular technologist and a second colour scanner. As a result, the majority of patients with peripheral vascular disease can have therapeutic decisions made (usually in the clinic) without unnecessary diagnostic angiography. Figure 4 shows the decline in the annual number of angiograms performed as vascular ultrasound became an alternative technique. During 1994 and 1995 about 34% of patients who underwent reconstructive surgery did so without preliminary angiography or angioplasty.[6] As the number of diagnostic angiograms has fallen the Radiology Department has been able to concentrate on interventional procedures. As a consequence, the number of peripheral angioplasties has increased from 190 in 1990 to 668 in 1996. As vascular ultrasound has minimal risk, repeat leg scans are probably carried out

more often than repeat angiograms would have been, therefore increasing the number of leg scans compared to angiograms previously performed.

Graft surveillance scans

In this unit, it is our policy that once patients are entered onto the graft surveillance program they are followed up for life. This therefore explains the rapid increase in the annual number of surveillance scans, as the number of infrainguinal reconstructions has not changed significantly. Except for an initial post-operative clinic visit, the patients do not see a vascular consultant unless they develop a problem. Graft surveillance along with percutaneous transluminal angioplasty (PTA) improves the cumulative patency rate of infrainguinal vein grafts.[7] If a stenosis is detected this is treated and the patient re-entered onto the surveillance program as if they had a new graft, i.e. followed up at 1, 3, 6, 9 and 12 months and then 6-monthly following treatment. The number of graft surveillance scans carried out depends on both the number of new patients joining the surveillance program and on the number of graft stenoses treated. The number of bypass operations performed has remained reasonably constant during this study. A prospective study of the effectiveness of graft surveillance of prosthetic grafts was carried out in the unit during 1994 and 1995 and showed that surveillance did not significantly influence long-term prosthetic graft survival.[8] It was therefore decided to phase out graft surveillance on patients with prosthetic grafts from mid-1995, and this has reduced the annual rate of workload increase in this group of patients.

Vein scans

The majority of vein scans have been carried out for the assessment of incompetence rather than deep vein thrombosis (DVT). The Radiology Department provides the hospital DVT diagnosis service and the VSU provides a DVT diagnosis service solely for the vascular surgeons. Figure 5 shows the increase in the use of ultrasound in the assessment of deep and superficial vein incompetence. The rise in workload is partly due to a more aggressive operative approach to the treatment of venous ulcers by the vascular surgeons. This has included the implementation of single visit venous ulcer clinics where the patients are seen by the vascular surgeon, assessed by vascular ultrasound and a decision on optimum treatment made, at the same outpatient visit.[9] This service was established in May 1994 and has generated an increase in the number of scans carried out as shown by Fig. 5. Vein scans are also routinely requested for patients with recurrent varicose veins and these patients usually attend for a scan at the VSU on a separate occasion. In addition, ultrasound is used to mark the saphenopopliteal junction and the position of incompetent perforators prior to surgery. Vein mapping is routinely used to assess the suitability and the anatomical path of the long saphenous vein for use in bypass surgery.

Conclusions

This study of the workload in the VSU at the Leicester Royal Infirmary has shown that the number of tests performed has tripled over the last 7 years. The change has been influenced by technological advances, surgical demand and the availability of resources. Vascular ultrasound has developed into the investigation of choice providing an accessible and non-invasive diagnosis of carotid artery disease, lower limb arterial disease and venous assessment, and has largely replaced diagnostic angiography in our practice. However, confidence in colour Doppler ultrasound as the only preoperative investigation is not shared by all centres. This rapid growth in vascular ultrasound is liable to continue, especially with the potential for aortic aneurysm screening, aortic endovascular graft surveillance, renal artery assessment and the possibility of direct access to general practitioners. This must, however, be governed by access to appropriate resources. In order to demonstrate the need for allocation of further resources, it is vital to maintain a good audit system.

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